IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

George G. Zipfel, Jr. et al **Attorney docket No:** Zipfel 1

Serial No.: 10/783,499 **Art Unit:** 2817

Filed 02/20/2004 **Examiner:** SHINGLETON, Michael B.

Title: SWITCHING AMPLIFIER FOR DRIVING REACTIVE LOADS

COMMISSIONER FOR PATENTS
WASHINGTON D.C. 20213

SIR:

DECLARATION UNDER 37 C.F.R. 132

George G. Zipfel, Jr. residing at 164 Canoe Brook Parkway, Summit, New Jersey, hereby declares as follows:

1. I have been employed by Summit Applied Research, Inc from 1996 to the present, designing electronics, active vibration control, acoustic systems R&D for DARPA and US Navy
2. I was employed by AT&T Bell Laboratories, Inc., Electronics, transducer, active vibration control, sonar, system and subsystem R&D for the US Navy, US Air Force, and DARPA from 1973 to 1996
3. I was a National Research Council Postdoctoral Research Associate at Naval Research Laboratories, acoustic systems and analysis from 1971 to 1973
4. I was Post Doctoral Research Associate at SUNY Stonybrook, NY from 1968-1971.
5. I received PhD in Physics, University of Michigan, Ann Arbor, MI in 1968.
6. I received MSE in Electrical Engineering, University of Florida, Gainesville, FL: in 1962
7. I received BS in Electrical Engineering, MIT, Cambridge, Main 1961
8. I received BS in Physics, MIT, Cambridge, MA in 1960
9. This document relates to the outstanding rejection of all the claims of the above-identified patent application as being unpatentable under 35 U.S.C. 112.
10. The Office action has stated that the conclusion that $[i_{L1}(t) + i_{L2}(t)] \approx 0$ is not supported by the drawings or their description. The Office action states that the description on pp. 11 and 12 of the specification does not support the statement in the specification that as baseband current flows through load L1, a substantially equal amount of baseband current flows in the opposite direction through L2.

Indeed, the Office action concludes that pp. 11 and 12 appears to describe the exact opposite.

11. Firstly, I would address the question of the convention of how current flow is shown. Figure 4A and subsequent figures indicate the convention for direction of current flow that corresponds to positive current flow. When current does flow in the direction of an arrow (e.g., "down" in FIG. 4A), then the numerical value of that downward-flowing current is a positive value, such as +2 mA. Thus if the instantaneous current $i_{L1}(t)$ through load L1 is flowing "down" at a given point in time, then, algebraically, $i_{L1}(t) = 2$ mA. When current flows in the opposite direction (e.g. "up" in FIG 4A), then the numerical value of that downward-pointing current is a negative value because the current is flowing in a direction opposite to the arrow, such as -2 mA. Thus if the current $i_{L2}(t)$ through load L2 is flowing "down" at a given point in time, then, algebraically, $i_{L2}(t) = -2$ mA. Therefore $[i_{L1}(t) + i_{L2}(t)] = [+2 + (-2)] = 0$.
12. However, it would seemthat the examiner believes that in fact both of the currents $i_{L1}(t)$ and $i_{L2}(t)$ are flowing in the same direction at the same time because signals PWM and PWM' are both high or both low for a substantial amount of their cycles. Indeed, if this were a circuit with only non-reactive elements, one might be able to analyze the circuit in that way.
13. However, this is an ac circuit with reactive elements (i.e., inductors) and must be analyzed as such.
14. In particular, it is noted that currents $i_{L1}(t)$ and $i_{L2}(t)$ are baseband currents whereas signals PWM and PWM' have significant switching baseband components. Those components are acted on by common-mode inductor 41 and indeed, are substantially filtered from reaching the loads because they are common-mode signals. The storage and release of energy in the reactive elements of the circuit mean that one cannot simply conclude that the instantaneous currents in the loads L1 and L2 are the same whenever signals PWM and PWM' are the same (i.e., high or low.) That might be true in a circuit with only non-reactive—that is, purely resistive—elements. But here, in a circuit with reactive elements one cannot conclude that the instantaneous current flow in the loads L1 and L2 will be in phase with signals PWM and PWM,' respectively. It is noted that the analog baseband signals B and B' that give rise to signals PWM and PWM' are the inverse of one another. A consequence is that the widths of the pulses of signals PWM and PWM' are not the same at any given time. This is what gives rise to the opposite phases of the baseband signals flowing in the loads. This difference in pulse widths is ultimately manifest in the difference in the instantaneous direction of current flow of the baseband signals that flow in the two loads L1 and L2.
15. Looking specifically at the circuit of FIG. 4A taken as an example, the modulation scheme for the gate drivers has transistors 35 and 37 both being on and both being off for some fraction of the switching cycle. However, this does not mean that the voltage across the load terminals is (V_2-V_1)or (V_G-V_1) respectively because the impedance of the common mode inductor is between the transistor terminals and the load terminals. The voltage drops across the common mode inductor cause i_1 and i_2 to be almost equal and opposite. This is the function of a common mode inductor. It develops the voltages needed to make

the currents in the windings equal and opposite. (It may also be noted that if the common mode inductance were infinite, then the currents would exactly sum to zero. For a finite inductance, there will always be a deviation from zero. The choice of modulation format is such as to minimize the size of the inductor needed to make the currents sum to a value that is small enough to be essentially zero for practical purposes.)

16. I hereby acknowledge that I have been warned that any willful false statements and the like are punishable by fine or imprisonment, or both (18 U.S.C. 1001) and may jeopardize the validity of the application or any patent issuing thereon.
17. All statements made of my own knowledge are true and all statements made on information and belief are believed to be true.

George G. Zipfel, Jr.

Dated: May 9, 2005